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SAFETY GUIDELINES FOR LIGHTWAVE TRANSMISSION SYSTEMS

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1. GENERAL

1.01 This section identifies potential hazards to safety and health associated with lightwave transmission systems and prescribes guidelines for their evaluation and control.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

1.03 The intent of this section is to provide guidelines for the safe use of Lightwave Transmission Systems (LTS) such as the FT3, FT3C, or similar digital lightwave systems that utilize both laser and light-emitting diode (LED) transmitters. These guidelines are intended for use by personnel who are responsible for the installation, operation, servicing, and repair of lightwave transmission systems owned, operated by, or under the direction of the operating telephone companies.

1.04 The existing FT3, FT3C, and similar systems and the associated optical test sets use semiconductor laser transmitters that emit light at wavelengths of 0.82 micrometer (820 nanometers) or longer into lightguide cables. The emitted light is at the red end of the visible spectrum. Although officially designated as invisible, most people can see light at wavelengths up to approximately 1 micrometer. Lasers and laser products are subject to federal and state regulations as well as company standards for the safe use of lasers.

1.05 Lightwave systems using LED transmitters generally emit light at wavelengths longer than 1.0 micrometer (1000 nanometers). These wavelengths are in the near infrared region of the spectrum and usually cannot be detected by the human eye.

1.06 The manufacture of lasers and laser products (does not include LEDs) is regulated by the National Center for Devices and Radiological Health (NCDRH). Copies of these regulations are available from the Public Health Service of the Department of Health and Human Services as FDA Publication 79-8035. These regulations require manufacturers to certify each laser or laser product as a class I, II, IIIa, IIIb, or IV device or system, depending upon the characteristics of the laser emission. In addition, specific labeling, interlock, beam attenuation, etc, requirements are specified for each class. Various states also have issued user regulations covering lasers and laser products and a listing of these states is included in Table A. Additional information may be obtained from the Company Safety Coordinator. Operating telephone companies must comply with the specific regulations that apply in their particular states.

1.07 Some of the sections that must be read before it is safe to work on lightwave transmission systems are:

640-252-101	Lightguide Cable Splicing and Splice Testing
640-252-106	Optical Time Domain Reflectometer (OTDR)—Description and Use
640-252-107	Optical Loss Test Set (OLTS)—Description, Use, and Maintenance

NOTICE

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TABLE A

STATE	AGENCY	TITLE/DATE
STATES WITH CURRENT REGULATIONS, INCLUDING REGISTRATION		
Alaska	Dept. Envir. Conser.	Title 18, Art. 7 and 8 10/71
Georgia	Dept. Health	Ch 270-5-27 9/1/71
Illinois	Dept. Pub. Health	Registration Law 8/11/67
Massachusetts	Dept. Pub. Health	Sect. 51, Ch 111 10/7/10
New York	Dept. Labor	Code Rule 50 8/1/72
Pennsylvania	Dept. Envir. Resource	Ch 203, Title 25, Part 1 11/1/71
Texas	Dept. Health	Radiation Control Act, Parts 50, 60, 70 7/2/74
STATES WITH EXISTING REGULATIONS OR VOLUNTARY REGULATIONS WITH NO REGISTRATION REQUIREMENT		
Missouri	Dept. Health	Existing Ionizing Regulation Applies
Montana*	Dept. Health and Envir. Sciences	Reg: 92-003
Virginia	Dept. Health	Voluntary Program
Washington	Dept. Lab. and Ind.	Ch 296-62-WAC
STATES WITH ENABLING LEGISLATION PASSED		
Arizona*		HB-5 8/11/70
Arkansas*	Public Health	Act 460
Florida*	Div. Health	Ch 501-122
Louisiana*	Div. Radiation Control	HB-1165 7/31/68
Mississippi*	Dept. Health	HB-499 4/24/64
Oklahoma*	Health Dept.	HB-1405 4/14/69
STATES WITH EXISTING OSHA-STATE AGREEMENTS (NOTE 1)		
California	Labor Dept.	OSHA State
Colorado	Labor Dept.	OSHA State
Connecticut	Labor Dept.	OSHA State
Minnesota	Labor Dept.	OSHA State
North Carolina	Labor Dept.	OSHA State
STATES DRAFTING OR AWAITING PASSAGE OF REGULATIONS (NOTE 2)		
Alabama		Pending
Iowa		Pending
Maine	Health Eng.	Pending
Michigan		Pending
Nebraska		Pending
New Hampshire		Pending
New Mexico	Envir. Impvt. Agency	Pending
Oregon	Health Division	Pending
Wyoming	Div. Health	Pending

Note 1: Not covered by other standards at state level.

Note 2: Enabling legislation not passed.

* New regulations now being drafted or pending passage.

644-202-101 Lightguide Cable—Repair

644-202-102 LGA2 Lightguide Cable—Repair

2. LASER TRANSMISSION SYSTEMS

2.01 The FT3, FT3C, or similar lightwave digital transmission systems use a class IIIb semiconductor laser transmitter. In normal operation, these systems are totally enclosed and fully shielded by protective devices. Under these conditions, there is no accessible laser emission and, hence, it presents no hazard to safety or health. For this reason, these systems have been certified by the NCDRH as class I systems (exempt lasers and laser systems). All components of the FT3 and FT3C systems and associated test equipment that can be removed, allowing access to laser emission greater than the emission limits of class I, have been identified and labeled with the appropriate label as required by 21CFR1040.

2.02 The lightguide cables which interconnect various components in the systems can be deliberately disconnected or accidentally broken and, under some circumstances, can permit human access to lightwave emission.

2.03 In addition, certain measuring, service, and installation procedures may permit direct access to the emission from the class IIIb semiconductor laser. Normally, emission from a class IIIb laser can cause damage to the retina of the eye. However, the emission pattern of a semiconductor laser is a highly divergent beam unlike solid-state and gas lasers. This means that the power density in the beam and, hence, any potential risk for eye injury decreases rapidly with distance from the output connector. Inadvertently viewing an unterminated, energized, lightguide connector with the unaided eye at distances greater than 5 or 6 inches from the connector will not cause eye injury; for example, when looking into a vacant regenerator slot on the FT3 or FT3C systems with the unaided eye. However, damage may be possible if an optical instrument is used to view the laser emission. Optical instruments, as used here, includes a microscope, magnifying glass, eye loupe, etc, but does not include corrective eyewear or an indirect image converter such as the infrared viewer. (See Section 640-010-030.)

2.04 ***DANGER: The present infrared viewer in general use in the field was not designed to detect light emission in the long wavelength region (>1.2 microns). Thus, the absence of light detection with the infrared viewer does not verify that long wavelength lightwave emission is not present. Since certain installation and service operations require looking at deenergized fibers or connectors with eye loupes, a positive procedure is necessary to ensure the absence of long wavelength emission. To avoid any possibility of eye damage, therefore, no one shall attempt to verify the presence of a light signal at the end of a fiber or from a connector by looking directly into the end of the fiber or connector. The infrared viewer must be used to determine if a fiber is energized.*** In addition, under no circumstances should fiber continuity be verified by shining a flashlight into one end and viewing the other end of the fiber. The recommended method for verifying fiber continuity is the use of optical loss test sets per Sections 640-252-106 and -107.

2.05 Until a filtered eye loupe or an indirect image converter that responds to wavelengths greater than 1.2 micrometers is available, the following guidelines should be followed:

(a) During installation of a system, when no single fiber jumpers or plug-in equipment are present, use only a 0.8- to 0.9-micron optical loss test set (OLTS) and an infrared viewer for continuity or broken fiber checks.

(b) During loss measurements of a span, ensure that no splicing operations are being performed and that no one at the terminals is using any optical instruments. Maintain positive communications between the terminals under test during the measurement.

(c) During service or restoration activities or whenever energized lasers or LEDs are present, use the following routine:

(1) Establish communications; terminals to splice location.

(2) Verify at the terminals that the fibers or ribbons to be worked on do not have equipment connected.

(3) Using the 0.82-micron OLTS at the terminal and the infrared viewer at the splice, check fiber and ribbon identity.

(4) After identification, remove the OLTS source and notify the splicer.

(5) Splicer checks once more with the infrared viewer to ensure that the OLTS is removed.

(6) If no light is detected in Step (5), the splicer may examine the fibers with an eye loupe.

(7) Splicer notifies terminal end when examinations are completed.

(8) Should terminal ends be left unattended by craft during fiber splicing work, fibers or ribbons being worked on shall be tagged to prevent inadvertent connection of light sources. A sample tag is shown in Fig. 1.

3. LED SYSTEMS AND TEST SETS

3.01 Digital lightwave transmission systems that use LED transmitters generally emit light at wavelengths greater than 1.0 micrometer (1000 nanometers). The potential risk for injury from an LED system is slightly less than that from a similar system using a laser transmitter.

3.02 Since the type of transmitter may not always be known, all safety procedures that apply to the laser systems shall also apply to the LED systems for purposes of uniformity and safety. The only exception is that there is no requirement for the "Danger" label on the back plane of LED equipment, as specified in paragraph 5.01, for laser equipment.

3.03 There are, at present, two different classes of optical test sets in use: the optical loss test set (OLTS) and the optical time domain reflectometer (OTDR). Although the AT&T Technologies OTDR uses a class I laser, many of those available from the general trades, as well as the OLTS, make use of class IIIb lasers. Thus, all control measures in Part 5 apply to the use of the optical loss test sets.

4. SPECIFIC RESPONSIBILITIES

4.01 The Human Resources Department of Bell Communications Research; the Environmental Health, Environmental Management and Safety Department of Bell Laboratories; and the Laser Studies Group of AT&T Technologies Engineering Research Center are responsible for:

Fig. 1—Sample Warning Tag

(a) Providing background information on lasers and lightwave transmission systems

(b) Providing laser classification and laser safety information

(c) Providing guidance on the use and adequacy of laser safety equipment and practices.

4.02 The operating telephone company safety organization is an integral part of the lightwave safety program. Their specific responsibilities include:

(a) Obtaining and maintaining an official file of the appropriate federal, state, local, and com-

pany regulations applicable to lightwave transmission systems

(b) Ensuring that lightwave transmission systems are classified in accordance with all applicable regulations

(c) Conducting periodic safety surveys to ensure that prescribed practices and procedures are being followed

(d) Coordinating the educational, engineering, supervisory, and enforcement activities related to the safety program for lightwave transmission systems.

4.03 The supervisor in the operating telephone company is responsible for maintaining safe working conditions for all employees engaged in the installation, operation, or service aspects of lightwave transmission systems. Specific responsibilities include:

(a) Maintaining a work environment that assures safe and healthful conditions for employees

(b) Ensuring that all employees working with lightwave transmission systems or scheduled to attend company schools for lightwave systems training are included in the Medical Surveillance Program described in Part 6

(c) Instructing employees periodically on the precautions, procedures, and practices that are applicable to lightwave transmission systems

(d) Ensuring, insofar as possible, that lightwave transmission systems and any associated test equipment are properly operated and controlled to protect transient or uninformed personnel that may be in the area.

4.04 Each employee engaged in the installation, operation, or service of lightwave transmission systems is responsible for:

(a) Observing all rules, procedures, and practices established for the safe operation of these systems

(b) Notifying supervision immediately of conditions or practices that have the potential to cause personal injury or property damage

(c) Reporting immediately to supervision any known or suspected abnormal exposure to laser radiation. See Part 5 for normal procedures.

4.05 The operating telephone company Medical Director is responsible for initiating and conducting a medical surveillance program (Part 6) for employees engaged in the installation, operation, or service of lightwave transmission systems. Specific responsibilities include:

(a) Recommending the placement only of those employees whose physical health meets minimum requirements for work with lightwave transmission systems (Part 7)

(b) Examining or arranging for the examination of those employees required to have medical examination (Part 6)

(c) Maintaining all records specified in Part 8 of this section.

5. SPECIFIC CONTROL MEASURES

5.01 Under normal operating conditions, lightwave transmission systems are completely enclosed and the following precautions should be observed.

(a) ***Employees must not disconnect any lightguide cable and look into the optical connector terminating the cable because of the potential risk of eye damage.***

(b) Because viewing lightwave emission directly with an optical instrument (eg, a magnifying glass, microscope, eye loupe, etc, but not corrective eyewear or an indirect image converter such as an infrared viewer) greatly increases the possibility of eye damage, an appropriate label must be located on the front of the main frame in plain view. The wording of the label should contain the words:

NOTICE
UNTERMINATED OPTICAL CONNECTORS MAY EMIT LASER RADIATION. DO NOT VIEW BEAM WITH OPTICAL INSTRUMENTS.

In addition, federal regulations require labels on the back plane of laser equipment near each connector field with the words:

DANGER
INVISIBLE LASER RADIATION WHEN OPEN.
AVOID DIRECT EXPOSURE TO THE BEAM.

5.02 Under ***installation or servicing*** conditions, lightwave transmission systems can no longer be considered as enclosed. Under these conditions, the following practices must be followed:

(a) Only authorized, trained personnel shall be permitted to install or perform service on lightwave transmission systems, and effort must be taken to avoid exposing the eye to emissions from unterminated, energized, optical connectors at close distances. The connectors associated with the FT3 and FT3C lightwave regenerators are recessed, thereby limiting the exposure distance, so that the regenerators may be removed or replaced without fear of eye injury. However, personnel performing the removal or replacement must not stare or look directly into the vacant regenerator slot with optical instruments or magnifying lenses.

(b) Only authorized, trained personnel shall be permitted to use lightwave test equipment during installation and/or servicing since this equipment contains semiconductor lasers.

(c) All unauthorized personnel shall be excluded from the immediate area of lightwave transmission systems during installation and servicing when there is a possibility that these systems may become energized.

5.03 In case of an accidental break in the lightguide cable or accidental removal of a lightguide cable from its normal position, the following steps shall be followed:

(a) By other than trained installation and/or service personnel:

(1) Do not examine or stare into broken, severed, or disconnected lightguide cables. Although the NOTICE shown in paragraph 5.01(b) clearly defines the hazard associated with lightwave transmission systems and specifies appropriate safety precautions, ***all unnecessary exposure to the eye to lightwave emission should be avoided.***

(2) Contact the supervisor to arrange for trained personnel to repair or replace the cable.

(b) By trained installation and/or service personnel:

(1) Report the problem to the supervisor.

(2) Do not view broken cables with any optical instruments other than an indirect image converter, such as the infrared viewer, unless it has been verified that all lightwave emission has been turned off.

(3) During all splicing operations that require viewing the end of the fiber, it is mandatory that all lightwave sources on the fiber involved be deenergized.

(4) Because of the danger of getting small slivers of fiber in the eye, it has been established that if eyewash is ***not*** carried in the vehicle, special eye protection (dust and splashproof goggles) must be worn. If the latter is done, then eyewash ***is not*** required.

6. MEDICAL SURVEILLANCE

6.01 Personnel assigned to work routinely on lightwave transmission systems (lightwave personnel) whose job function requires that they disconnect optical connectors on energized fibers, use optical test equipment such as the optical loss test set (OLTS) or the optical time domain reflectometer (OTDR), or engage in lightguide splicing operations where there is a possibility that the fiber may be energized ***must*** be included in a medical surveillance program. The purposes of this program are:

(a) To establish a baseline of ocular conditions against which any suspected damage can be measured in the event of a known or suspected exposure to lightwave emission

(b) To detect and document potential lightwave-related eye damage as soon as possible

(c) To identify those personnel who may be at special risk from exposure to lightwave emission.

6.02 The rationale for medical surveillance requirements for lightwave personnel and specific information on the recommended medical examinations are based on the Bell System Standard for the Safe Use of Lasers, Issue 2 (9/1/81).

6.03 Employees who work in the general vicinity of lightwave transmission systems, but have no occasion to come in contact with these systems, should not be included in the medical surveillance program.

7. MEDICAL EXAMINATIONS

7.01 Employees classified as lightwave personnel shall have a baseline eye examination before starting work on the lightwave system. This eye examination shall be as follows:

(a) The employee's past eye history and family history are reviewed. Any current complaints which the employee ***now*** has about his/her eyes are noted. Inquiry should be made into the employee's general health status, with a special emphasis upon diseases that may produce eye problems. The employee's present lens prescription and the date of the most recent prescription should be recorded.

(b) In the recording of the examination of the ocular fundus with an ophthalmoscope, the points to be covered are:

(1) The presence or absence of opacities in the media

(2) The sharpness of outline of the optic disc

(3) The color of the optic disc

(4) The depth of the physiological cup, if present

(5) The ratio of the size of the retinal veins to that of the retinal arteries

(6) The presence or absence of a foveal reflex

(7) Any retinal pathology that can be seen with an ophthalmoscope (hyper-pigmentation, depigmentation, retinal degeneration, exudates). Even small deviations from normal should be described and carefully localized.

(c) Visual acuity for far and near vision should be measured on an apparatus such as the orthorator, vision tester, sight screener, or Snellen chart, and an appropriate vision reading card. Near vision reading cards are available from major optical manufacturing or supply companies and should be used according to directions. Notation should be made of the apparatus/card used. If visual acuity is found to be 20/20 in each eye for far and near (corrected with lenses, if worn), no further examination is required.

(d) If the visual acuity corrected is less than 20/20 in either eye for far vision using the apparatus listed above, an examination using the Snellen chart at 20 feet should be done. Each eye must be tested individually, with the contralateral eye completely occluded. The results based on the Snellen chart should be taken as the final examination. If the visual acuity corrected is found to be less than 20/20, an ophthalmological consultation should be obtained.

(e) If the visual acuity in either eye for near vision corrected, using the apparatus listed above, is less than a Jaeger equivalent of 1, or Snellen 20/20, an examination using an appropriate near vision card should be done. The results of the vision card should be taken as the final evaluation. If the visual acuity corrected is found to be less than a Jaeger equivalent of 1, or Snellen 20/20, an ophthalmological consultation should be obtained.

(f) The ophthalmological consultation should include manifest refraction and a slit lamp examination. Fundus photography is not encouraged.

7.02 Lightwave personnel shall be examined prior to working with lightwave transmission systems, immediately after a suspected abnormal exposure of the eye, or for specific eye complaints on an individual basis. Periodic examinations are not required but may be offered in special circumstances.

8. RECORDS

8.01 Complete and accurate records of all medical examinations (including specific test results) shall be maintained for each employee included in

the medical surveillance program. Records should be retained for at least 30 years.

8.02 The results of medical examinations should be discussed with the employee.

8.03 All nonpersonally identifiable records of the medical examinations required in Part 5 of this section shall be made available on written request to authorized physicians and medical consultants and, upon the request of an employee or former employee, to his or her physician.